

Section 918. ELECTRICAL AND LIGHTING MATERIALS

918.01 Conduit. All conduits shall be UL labeled. Where cables are encased in concrete, concrete shall be Grade P3 per section 601 and if steel reinforcement is called for, reinforcement shall meet section 905.

- A. **Galvanized Steel Conduit.** Galvanized steel conduit shall meet ANSI C80.1. Galvanized steel conduit shall be manufactured according to UL 6 and shall be UL listed and labeled.

Couplings and fittings shall meet ANSI C80.4 and be hot-dipped galvanized. Elbows and nipples shall conform to the specifications for conduit. All fittings and couplings for rigid conduit shall be of the threaded type.

- B. **Smooth-Wall Schedule 40 PVC Conduit.** Smooth-wall polyvinyl chloride (PVC) conduit, fittings and accessories shall be manufactured from polyvinyl chloride meeting ASTM D 1784 and shall comply with all the applicable requirements of NEMA TC2 and UL 651.
- C. **Smooth-Wall Schedule 80 PVC Conduit.** Smooth-wall polyvinyl chloride (PVC) conduit, fittings and accessories shall be manufactured from polyvinyl chloride meeting ASTM D 1784 and shall comply with all the applicable requirements of NEMA TC2, UL 651.
- D. **Smooth-Wall Coilable Schedule 40 PE Conduit.** Smooth-wall coilable polyethylene conduit will be tested according to MTM 724. Conduit shall be marked according to ASTM D 3485. Markings must include a producer code and the designation HDPE or Type III, as appropriate. Conduit must be produced from material with a color and ultra-violet stabilization code of C, D, or E as defined in ASTM D 3350. All conduit for use above ground shall be black unless otherwise specified. Conduit shall be high-density polyethylene Type III, Grade P-33, Category 5, Class C, per ASTM -D3485, D3350 and D1248.
- E. **Smooth-Wall Coilable Schedule 80 PE Conduit.** Smooth-wall, coilable, polyethylene plastic conduit shall meet NEMA TC7, UL651 and 651A, ASTM D3485 or ASTM D2447 applicable sections. Conduit shall be high-density polyethylene Type III, Grade P-33, Category 5, Class C, per ASTM -D3485, D3350 and D1248.
- F. **Rigid Fiberglass.** All conduit and fittings shall be filament wound consisting of E-glass and corrosion resistant epoxy resin manufactured for use at temperatures from -40 °F to 230 °F. Conduit shall be pigmented carbon black for ultraviolet protection and fire resistant per UL 94. All fiberglass conduit shall be heavy walled (HW) and meet the specifications, labeling and testing of ANSI/NEMA TC14.

918.02 Electrical Grounding System. The materials for the electrical grounding system shall meet the following requirements.

- A. **Flexible Grounding Connection.** The flexible grounding connection shall be made of extra flexible, flat, tinned copper braid, with seamless tinned copper ferrules at each end, having a minimum cross sectional area equal to that of the grounding cable. The ferrule shall be capable of being formed to fit the curved surfaces of a clamp or pipe.

- B. **Grounding Cable and Bonding Jumper.** The grounding cable and the bonding jumper shall be a No. 2 AWG, 19 stranded bare soft copper wire conforming to ASTM B 8.
- C. **Grounding Rod.** The grounding rod shall be a ¾ inch minimum diameter copper clad steel rod of 10 foot minimum length having no more than 10 ohms resistance to ground.
- D. **Connecting Hardware.** The connecting hardware shall be silicon bronze conforming to ASTM B 124M. All materials shall be supplied by the same manufacturer to ensure compatibility.

918.03 Electrical Wire and Cable. All wire and cable shall conform to the National Electrical Code (NEC) and any local ordinances which apply and shall meet all applicable ASTM specifications. Cable shall be UL approved. Conductors shall be coated soft drawn copper and be standard American Wire Gauge (AWG) sizes as noted on the plans.

All wire and cable shall have the size, voltage rating, type of insulation and the manufacturer's name permanently marked on the outer covering at regular intervals. The manufacturer shall furnish to the Engineer and the Contractor all splicing or terminating information necessary for proper installation of the cable. Bare ground conductors shall be soft drawn copper.

- A. **Overhead and Underground Service Wire and Cable.** The cable shall consist of two - 1/C polyethylene insulated conductors assembled under a common polyethylene jacket. The cables shall meet IMSA 20-1 (aerial and duct) as modified by the following: The size and number of conductors shall be as shown in the contract documents. In addition, the insulation thickness for Nos. 6-8 AWG shall be 1143 microns (average) and 1016 microns (minimum).
- B. **Traffic Signal Wire and Cable.** These cables are for use in aerial, underground duct, or direct burial systems. All cables, except No. 51-5 (loop), shall be polyethylene insulated and polyethylene jacketed with 2 to 20 conductors. The No. 51-5 (loop) shall be polyvinyl chloride insulated, nylon jacketed, loosely encased in a polyethylene tube. The size and number of conductors shall be as shown on the plans or as listed in the proposal.

The cables shall meet IMSA 20-1 (aerial and duct); 20-3 (aerial self-supporting); 20-5 (direct burial); 40-2 (aerial and duct); 40-4 (aerial self-supporting); 50-2 (loop lead-in); 51-5 (loop), with the following exceptions and additions:

- 1. **Conductors.** The conductors of all cables shall be concentric stranded, Class B, soft copper meeting ASTM B 8, except that no joints of any kind are permitted in the conductors after completion of the final drawing operations.
- 2. **Circuit Identification.** Color coded insulation shall be used per Table 5.1 of IMSA 20-1, 20-2 and 20-5; Table 5.2 of IMSA 40-2 and 40-4. Numerals or words printed on the insulation for the purpose of conductor identification are not acceptable.
- C. **Messenger Cable.** The messenger cable shall be stranded, maximum 7-wire, ¼ inch, Class C, galvanized, extra high strength steel strand meeting ASTM A 475, as specified

under 9.1-A of IMSA 20-3 (aerial self-supporting) and 11.1 of IMSA 40-4 (aerial self-supporting).

918.04 Direct Burial Cable. All direct burial cable shall be installed in conduit unless otherwise noted on the plans.

Direct burial cable in conduit shall be approved for use in wet locations according to the National Electrical Code.

All cable shall be UL listed and unless otherwise indicated, shall be rated at 600 volts. The cable shall be rated 194 °F dry and 167 °F wet and be suitable for installation in wet and dry locations, exposed to the weather, and be resistant to oils and chemicals. The cable shall meet UL 44.

Any cable used for an electric service entrance run shall have a rating which includes a USE rating. Cable sized No. 2 AWG and smaller shall be UL listed Type RHH/RHW and may be Type RHH/RHW/USE.

Cable sized larger than No. 2 AWG shall be UL listed Type RHH/RHW/USE.

The UL listing mark, cable voltage, insulation type and ratings, as well as the cable size shall all be clearly printed on the cable in a color contrasting with the insulation color.

- A. **Conductors.** Conductors shall be uncoated copper meeting ASTM B 3 and shall be Class B stranded per ASTM B 8. The manufacturer's insulation curing process shall be non-injurious to the uncoated conductors. Conductors shall be UL 44 approved.

The insulation on cables sized larger than No.2 AWG shall be color coded by having not less than 12 inches of cable ends length field-taped with half-lapped color tape.

All electric cables smaller than No. 2 AWG shall be color coded solid, painted full. Neutral wires shall be color coded white. Single phase 3-wire runs of cable shall be color coded one black, one red and one white and single phase 2-wire runs shall be similarly color coded based on the applicable phase(s) and neutral. Insulated ground wires shall be green.

918.05 Equipment Grounding Conductor. Grounding conductors shall be bare, annealed copper wire meeting ASTM B 3 and shall be stranded per ASTM B 8, Class B.

918.06 Handholes.

- A. **Concrete.** Concrete shall be Grade P2 meeting section 601.
- B. **Steel Reinforcement.** Steel reinforcement shall be No. 15 bar or welded cage mesh as shown on the plans.
- C. **Frame and Covers.** Frame and Covers shall be made of steel and classified as light duty or heavy duty. All covers shall read "MDOT ELECTRIC, TRAFFIC SIGNAL" or "TRAFFIC

CONTROLS" with the location and size of the letters as specified on the handhole detail sheet.

1. **Light Duty Cover.** Light duty covers shall be of the type specified on plans or an approved equal.

Round Cover - East Jordan #2982A-18 or
Neenah Foundry #R-6012-D

2. **Heavy Duty Cover.** Heavy duty covers shall be of the type specified on plans or an approved equal.

Round Cover - East Jordan #2860A or
Neenah Foundry #R-6052-D

- D. **Polymer Concrete Handhole Boxes and Covers.** The handhole box shall be constructed of polymer concrete and reinforced by a heavy weave fiberglass.

The enclosure and covers are to be heavy duty, designed and tested to -50 °F, and have a compressive strength of at least 11,000 psi. Covers shall have a minimum 0.5 coefficient of friction.

1. **Boxes.** The handhole boxes shall be a nominal size of 17 by 30 by 12 inch, be heavy duty and rated for 5000 pounds over a 10 by 10 inch area, and be stackable.
2. **Covers.** The handhole covers shall have a service load of at least 15000 pounds over a 10 by 10 inch area, have a logo imprint of "TRAFFIC SIGNAL" or "TRAFFIC CONTROL", and be secured by series 300, $\frac{3}{8}$ inch - 16NC hex stainless steel bolts and washers.

918.07 Light Standard Foundation.

- A. **Concrete.** Concrete shall be Grade P2 meeting section 601.
- B. **Steel Reinforcement.** Steel reinforcement shall be as shown on the plans and meet section 905.
- C. **Anchor Bolts, Nuts and Washers.** Anchor bolts, nuts and washers shall meet subsections 908.15.A and B. Anchor bolts shall be sized and placed (specified bolt circle) per the detailed plans for the specified light standard. Anchor bolt installation and tightening shall be according to subsection 810.03 J.

All anchor bolts one inch in diameter and greater shall have series 8UN threads. Anchor bolts less than one inch in diameter shall be coarse pitch. Anchor bolts shall be threaded a distance one inch greater than the anchor bolt projection shown on the plans.

- D. **Ground Rods.** Ground rod shall be copper clad steel $\frac{5}{8}$ inch diameter and 8 feet in length.

1. **Grounding Wire.** Grounding wire for the street lighting unit shall be No. 6 stranded bare copper wire.
2. **Conduit.** Conduit shall be provided in the foundation to allow for placement of conductors and grounding wires as shown on the plans and shall meet subsection 918.01.

918.08 Light Standards. Light standards shall be steel, aluminum or as specified on the plans. Poor welding workmanship as noted by visual inspection will be sufficient cause for rejection. Light standards shall be designed according to the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*. The Wind Importance Factor for the design wind speed shall be based on a recurrence interval of 50 years. The alternative method for determining the wind speed is not allowed. The Fatigue Importance Factor shall be Category I. Calculations for the design of the light standard shall be sealed by a professional engineer licensed in the State of Michigan and submitted to the Engineer for approval.

A. Steel Light Standards.

1. **Shafts.** The shaft shall be fabricated from either hot rolled low carbon steel or high strength low alloy steel, and shall have a minimum tensile yield strength of 50,000 psi either before or after fabrication.
2. **Handhole.** Each light standard shall have a reinforced handhole with a steel cover and a grounding nut or lug located inside the shaft easily accessible from the handhole.

3. **Anchor bases.** Anchor bases shall be one piece cast steel or hot rolled steel plate.

Cast steel anchor bases shall meet ASTM A 27, Grade 65-35.

Hot rolled steel plate anchor bases shall be fabricated of steel meeting ASTM A 36 or approved equal.

4. **Bracket Arm Assembly.** The bracket arm assembly shall be fabricated from steel conforming to ASTM A 53, Grade B or ASTM A 36.

The bracket arm assembly shall be the truss type design.

The installed bracket arm assembly shall provide a weather resistant connection with smooth wiring raceway.

5. **Welds.** All welding shall be done according to section 707. The shaft may have one longitudinal welded joint and one transverse welded joint as shown on the plans.

The welded area shall be free from flat spots, protuberances, cracks, discolorations, weld splatter, mill scale or any other imperfections which mar the appearance or structural continuity of the welded area.

Any circumferential butt weld splice and the base connection weld must be a full penetration weld and must be ground flush. The remaining portion of the longitudinal weld may be a minimum 60 percent partial penetration weld.

The base shall telescope onto the shaft and be welded by two continuous electric arc welds; one weld on the inside of the base at the end of the shaft and the other weld on the outside of the shaft at the top of the base.

6. **Galvanizing.** Light standards and all related components shall be hot-dip galvanized per ASTM A 123. The bracket arm assembly shall be galvanized separately.
7. **Hardware.** All threaded fasteners and lockwashers used to secure parts to the shaft shall be AISI Series 300 Stainless Steel.

B. Aluminum Light Standards.

1. **Shafts.** Aluminum shafts shall be round, octaflute, or octagonal, with a uniform taper.

The shaft shall be fabricated from a single piece of seamless tubing of aluminum alloy 6063 conforming to ASTM B 221, and, after fabrication, shall have physical strength properties as prescribed for the T6 temper.

All castings other than the shaft top shall be aluminum alloy 356-T6. Shaft top shall be aluminum Alloy 43F.

Sand castings shall conform to ASTM B 26. Permanent mold castings shall conform to ASTM B 108.

2. **Handhole.** Each light standard shall have a reinforced handhole, with a cover and a grounding nut or lug located inside the shaft easily accessible from the handhole.
3. **Bracket Arm Assembly.** The bracket arm assembly shall be fabricated from aluminum alloy pipe or tapered tubes.

Pipes shall conform to aluminum alloy 6063-T6 or 6061-T6 of ASTM B 241.

Tapered tubes shall conform to aluminum alloy 6063-T6 or 6061-T6 of ASTM B 221M.

The bracket arm assembly shall be of truss type design. The installed bracket shall provide a weather resistant connection with smooth wiring raceway.

4. **Welds.** Welding of aluminum shall be done according to Section 1.5.3 of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

All welding procedures shall be qualified by testing qualification welds as required by the Engineer.

The cast aluminum anchor base shall be secured to the lower end of the shaft by two continuous welds made by the metal inert-gas method using aluminum filler metal conforming to AWS Specification D1.2, *Structural Welding Code - Aluminum*.

The base shall telescope onto the shaft and one weld shall be on the inside of the base at the end of the shaft, while the other weld shall be on the outside of the shaft at the top of the base.

5. **Hardware.** All threaded fasteners, lockwashers, etc., used to secure parts to the shaft shall be aluminum alloy 2024-T4 or AISI Series 300 Stainless Steel.

- C. **Frangible Transformer Bases.** Any frangible transformer base shall meet the requirements for Breakaway Supports and section 7 of the current AASHTO *Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*.

Each frangible base shall be furnished with four bolts, hex nuts, washers, and lockwashers and fiberglass covers of the size shown on the plans. Tighten bolts to a snug tight condition as defined in subsection 707.03.D.7.c. The bolts shall conform to ASTM A 307 or equivalent.

- D. **Anchor Bolts.** All anchor bolts and associated nuts, studs, and couplings shall conform to subsection 908.15.

All anchor bolts shall be zinc coated for a length not less than 16 inches from the threaded end. All associated nuts, studs, washers, and coupling shall be hot-dipped galvanized according to ASTM A 153.

918.09 Luminaires.

- A. **High Pressure Sodium Luminaires.** (Cobra Head Type)

1. **Housing.** The luminaire housing shall be of cast or formed aluminum of adequate thickness to give structural rigidity.

The housing hood shall contain an integral slip fitter, suitable for mounting on either a 2-inch pipe bracket or a 1 ½ - inch pipe bracket (with insert if necessary).

Mechanical means for leveling the luminaire with a minimum range of ±3 degrees from the horizontal shall be provided. A leveling surface on the housing exterior shall be provided for mounting the luminaire in the proper operating position.

The hinge arrangements of the refractor holding ring shall allow the refractor to open at least 90 degrees from the horizontal.

The hinge shall have a locking arrangement to prevent the refractor holding ring from falling.

All exterior hardware and fasteners, wholly or partly exposed, shall be stainless steel, monel metal or aluminum alloy. The luminaire to bracket arm mounting fasteners and all internal fasteners shall be stainless steel or zinc coated steel. All remaining internal hardware shall be stainless steel, aluminum alloy, or zinc coated steel.

2. **Reflector.** The reflector shall be made of aluminum with an ALGLAS reflector finish or with a sealed anodic coating over either a electrolytically or chemically brightened specular surface.

The amount of anodic coating shall not be less than 4 mg/square inch per ASTM B 137.

The coating seal shall meet ASTM B 136.

The reflector shall be mounted to be removed for cleaning without special tools.

The gasket material shall be either ethylene-propyleneterpolymer (EPT), or a synthetic fiber felt.

3. **Refractor.** The refractor shall be made of clear borosilicate glass.

The refractor shall be compatible with the reflector to give the specified light distribution.

The refractor shall be securely mounted to the holding ring with provision for easy replacement.

4. **Ballast.** The ballast shall be of the magnetic regulator type or constant wattage auto regulator type.

The ballast shall be mounted entirely within the luminaire housing.

The ballast shall have a lamp wattage and circuit voltage clearly identified and shall meet the current ANSI specification.

Power factor shall be not less than 90 percent at rated voltage.

The ballast shall provide reliable starting at -20 °F over voltage variations of ± 10 percent of nominal.

Lamp starting pulse voltage shall not be greater than 4000 pulse peak volts.

5. **Lamps.** Lamps shall be high-pressure sodium vapor, as specified on the plans. High pressure sodium lamps shall conform to luminaire design burning position requirements.

6. **Socket.** The socket assembly shall be of rigid construction so that correct lamp position can be retained during service.

The socket material shall be nickel plated brass with a porcelain covering.

The socket shall contain lamp grips and the center contact shall be spring loaded.

The socket leads shall be welded or attached with crimp type, solderless, compression connectors.

Socket adapters for lamp positioning shall not be used. Information on correct socket position (if variable) shall be provided.

7. **Wiring.** All internal wiring and connection shall be completed so that it will be necessary only to attach incoming supply conductors to pressure type connectors on a terminal block.

Heat resistant protective tips or sleeves shall be furnished for the lamp cords if the lamp cord connections are directly above the lamp.

The terminal block shall be rated at 600 volts and meet NEMA *Specifications for Wiring Terminals*. The terminal board shall accommodate crimp-on solderless compression connectors for interior wiring.

The incoming supply conductors shall be mechanically and electrically fastened with compression terminals to accommodate wire from No. 12 to No. 6 AWG.

Type FNM fuses shall be furnished and be mounted as called for on the plans. The amperage rating of the fuses shall be as shown in Table 918-1.

Table 918-1 Fuse Ratings (Amperes)

Circuit Voltage	120	240	277	480
250 W	10	5	5	5
400 W	15	10	10	10
700 W	20	10	10	10
1000 W	30	15	15	15

- B. **Rectangular Luminaires.** Rectangular luminaires shall be as specified in the contract documents.

918.10 Tower Lighting Unit. Tower lighting units shall be designed according to the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*. The Wind Importance Factor for the design wind speed shall be based on a recurrence interval of 50 years. The alternative method for determining the wind speed is not allowed. The Fatigue Importance Factor shall be Category I. Calculations for the design of the light standard shall be sealed by a professional engineer licensed in the State of Michigan and submitted to the Engineer for approval.

- A. **Shaft and Base.** The steel shaft including the base shall be fabricated from steel meeting ASTM A 572, Grade 50, or A 607 Grade 50 with a maximum silicon content of 0.060 percent for the shaft and between 0.150 and 0.250 percent for the base plate. All material shall be single thickness steel plate with no laminations.

Design calculations shall be based on a yield strength F_y not to exceed 50,000 psi.

No section of the pole shall have a wall thickness less than $\frac{3}{16}$ inch. Anchor bolts, nuts and washers shall be according to subsections 908.15.A and B. Anchor bolt installation and tightening shall be according to subsection 810.03 J.

The overall diameter of the shaft shall be not less than 23½ inches at the base, with uniform taper to the top and a minimum diameter of 6 inches.

Fabrication shall be according to section 707, except as modified by this subsection.

1. **Handhole.** Shafts shall be furnished with hinged doors of the same material as the shafts. The door size shall be 24 by 14 inch minimum and shall be provided with a hasp, for padlock. The access holes shall be placed so they do not intersect the longitudinal seam weld on the pole.
2. **Galvanizing.** Poles and all related components shall be hot-dipped galvanized per ASTM A 123.
3. **Welds.** Use submerged arc welding (SAW) for longitudinal seam and circumferential welds. Circumferential seams shall be full penetration groove welds.

Longitudinal seams at slip joints (1½ diameters) and welded splice areas shall be full penetration groove welds on both sections for a distance of 10 inches beyond the splice end.

Weld reinforcement shall be ground flush on the faying surfaces in the slip joint area for the entire length of the full penetration weld.

Longitudinal welds other than in the slip joint area shall have 60 percent minimum penetration.

Base plate joints shall be full penetration single bevel groove welds with reinforcing fillet welds.

The Contractor shall provide non-destructive testing, as specified, on all welds. The UT and MT shall be performed by personnel qualified as NDT Level II or Level III per ASNT STN-TC-1A. Both MT and UT shall be witnessed by the Engineer. Certified inspection reports from the ANST inspector shall be given to the Engineer for all welds tested.

- a. **Magnetic Particle Testing.** Magnetic particle inspection testing (MT) shall be performed on all welds according to subsection 707.03C.9.b.
- b. **Ultrasonic Testing.** Full penetration groove welds shall be 100 percent ultrasonic tested (UT) using the shear wave or angle beam method. UT shall be according to ASTM E587-94, Standard Practice for Ultrasonic Angle Beam Examination by the Contact Method and the American Welding Society (AWS) D1.1 Structural Welding Code-Steel, except as modified herein.

The full penetration groove weld of the slip joints are to be evaluated by UT as cyclically loaded nontubular connections. These requirements set guidelines for

evaluating by UT indications in materials thinner than $\frac{5}{16}$ inch shown in Table 6.3 of the AWS D1.1. The thickness of the material and the near field of the transducer shall be established prior to the start of inspection to assure relevant indications can be detected with repeatable results. Flaws shall be evaluated in the location of the sound path beyond the first leg, which is required in Table 6.6 of AWS D1.1. Establishing the material thickness and near field of the transducer assures that near field interference is not a factor in the testing.

Inspection test reporting shall be completed using Form D-11 of Annex D, AWS D1.1 or an equivalent form that contains the necessary information for identifying and classifying indications found during the inspection process.

- c. **Equipment and Calibration.** Ultrasonic units shall be of the pulse-echo type and shall be capable of generating, receiving, and amplifying electrical impulses for the desired application. All instruments shall be equipped with a decibel (dB) or attenuation control and shall be calibrated to assure satisfactory performance in the range of operation. Equipment qualification shall be according to Section 6.24 of AWS D1.1.

The search unit (transducer) shall be of the piezo-electric type coupled to a 70 degree wedge. The angle shall be verified to be within ± 2 degrees, prior to calibration for testing. The exit point shall be accurately marked on the side of the transducer if different from the original exit point.

Search unit frequency shall be 5.0 megahertz and the diameter shall be $\frac{1}{2}$ inch or less. The near field shall be calculated by the equation:

$$N = (D^2 \times F) \div (4 \times V) \quad \text{or} \quad D^2 \div (4 \times W) \quad \text{where } W = V \div F$$

Where: D = transducer diameter
 F = frequency
 V = velocity
 W = wavelength

Couplant shall be of the glycerin type. Calibration shall be performed with the same type couplant that will be used for inspection.

Prior to beginning the calibration procedure, the operator shall verify that the reject (clipping or suppression) controls are turned off. Use of the reject controls may alter the amplitude linearity of the instrument and invalidate the test results. Calibration of the ultrasonic equipment shall be according to Section 6.25 of AWS D1.1.

- d. **UT Acceptance Criteria.** Ultrasonic inspections shall be according to Section 6.13 of AWS D1.1. The inspection shall be performed beyond the first leg of the sound path, to avoid the near field effects. When indications are recorded, the leg of the

sound path where the signal is peaked shall be noted. The sound path, or full V-path, shall be calculated as follows :

$$SP (FVP) = \frac{2T}{\cos \ominus}$$

Where : T = material thickness,
 \ominus = wedge angle

The accept/reject criteria shall be according to Table 6.3 of AWS D1.1 for 5/16 inch material thickness, except that the values shown in the table are reduced by 10 dB. The 10dB reduction is to account for the thinner material being tested and the modified frequency and diameter of the search unit.

Surface preparation shall be such that the transducer can be freely manipulated through the full surface area for the sound path to be evaluated. This may require grinding or other means of cleaning prior to inspection. Testing procedures shall be according to Section 6.26 of AWS D1.1. Attenuation shall be calculated according to Section 6.26.6.4 of AWS D1.1. In most cases attenuation will not be a factor, due to the short length of the sound path in thin materials.

4. **Fabrication.** Test records shall be kept by the supplier and shall be available for review upon request.

Welding of identification marks or any other stray tack welds on the poles is prohibited.

All steel components and welds must be properly cleaned by sand blasting or other methods approved by the Engineer before galvanizing.

Preheat shall be verified by the use of Tempil indicating crayons or direct temperature instruments.

- B. **Head Frame Assembly.** The headframe assembly shall provide a pair of pulleys properly located for each stainless steel cable used to support the luminaire ring. In addition, either a roller assembly or a single pulley for the power cord shall be provided. The hoisting system may consist of two or three stainless steel cables at the head frame assembly.

1. **Power Cord Roller Assembly.** Where a roller assembly is used to support the power cord, the assembly shall consist of six rollers mounted between two cold-rolled steel plates which are zinc-electroplated per ASTM B 633 and yellow chromatic dipped. The power cord shall ride on rollers made from acetate resin meeting ASTM D 2133-65, Grade II mounted on AISI 304 stainless steel shafts. The six rollers shall be located to support the power cord in a minimum 7 inch bending radius. All parts of the assembly shall be fabricated from ASTM A 572 Grade 345 steel except the pulley and rollers.

The assembly shall be designed to protect all parts from the weather.

2. **Power Cord Pulley.** Where a pulley is used to support the power cord, it shall be a minimum of 16 inches in diameter and fabricated from a single piece of galvanized steel.
3. **Pulleys for Stainless Steel Support Cables.** Pulleys used for the stainless steel cables shall have a minimum diameter of 6 inches and be fabricated in one piece from either stainless steel or galvanized steel.

All pulleys shall have permanently lubricated bronze bearings and stainless steel axle pins. The depth of the vee on all pulleys shall not be less than the diameter of the cable for which it is to be used and guards shall be provided to prevent cables from riding off the pulleys.

4. **Latching.** Provisions for latching the luminaire mounting ring may be located at the head frame assembly or at the base of the pole.

Where latching is completed at the head frame assembly, three latches will be an integral part of the head frame assembly. Latching shall be accomplished by the alternate raising and lowering of the luminaire ring assembly by the winch and hoisting assembly. All moving parts of the latching mechanism shall be attached to the luminaire ring assembly and serviceable at ground level. The luminaire ring shall not move horizontally or rotate about the pole during the latching or unlatching process. The latching and locking of each latching mechanism shall be signaled by indicator flags visible from the ground.

Where a two cable hoist system is used, latching of the luminaire mounting ring will be accomplished only at the base of the pole. Each supporting cable shall be latched into place by a cable anchoring device.

- C. **Luminaire Mounting Ring.** The luminaire mounting ring shall support 2-inch diameter mounting tenons complete with ballasts, evenly distributed around the ring for mounting the specified number of luminaires. It shall provide a suitable raceway, or enclosure, for all required electrical connections to the luminaires.

The mounting ring shall be furnished with not less than No. 12 AWG copper wire rated at 200 °F.

The luminaire mounting ring and related components shall be fabricated from galvanized steel. Galvanizing shall be by the hot-dip method of ASTM A 123, after welding fabrication.

The luminaire mounting ring shall be equipped with a weather proof male receptacle for conveniently energizing the luminaires when the ring is in its lowered position. Connections shall be weathertight and protected when the luminaires are in the operating position.

Provisions shall be made for centering and damping any contact the luminaire mounting ring may encounter while ascending and descending the pole.

Roller-contact with spring-loaded centering arms located on the luminaire mounting ring shall be provided. The luminaire ring centering device shall be capable of keeping the ring approximately concentric with the pole.

- D. **Luminaires.** The luminaire when installed shall be of adequate design to operate at mounting heights in excess of 100 feet. It shall withstand wind velocities of 120 feet per

second and resulting vibrations. The luminaire shall not weigh more than 94 pounds. When mounted in operating position the projected area exposed to the wind shall be not more than 5.4 square feet.

The luminaire shall meet the following requirements:

1. **Housing.** The luminaire housing shall be cast or formed aluminum with 0.2 percent maximum copper content and of adequate thickness to give structural rigidity. The housing shall contain an integral slip fitter, suitable for mounting on either a 2-inch pipe bracket or a 1½ inch pipe bracket (with insert if necessary). Mechanical means to limit insertion of the pipe arm shall be provided. Mechanical means for leveling the luminaire with a minimum range of ±3 degree from the horizontal shall be provided.

A leveling surface on the housing exterior shall be provided for mounting the luminaire in the proper operating position. Luminaires producing asymmetrical light distributions shall be capable of being oriented to distribute the light as shown on the plans. All exterior hardware and fasteners, wholly or partly exposed, shall be stainless steel, monel metal, or aluminum alloy. The luminaire to bracket arm mounting fasteners and all internal fasteners shall be stainless steel or zinc coated steel. All remaining internal hardware shall be stainless steel, aluminum alloy, or zinc coated steel.

2. **Reflector.** The reflector shall be aluminum or glass. The reflector shall be gasketed to the refractor or cover glass. The gasket material shall be either extruded silicone rubber or a synthetic fiber felt.
3. **Aluminum Reflector.** Aluminum reflectors shall be enclosed and all optical parts shall be weather tight and bugtight. The reflector shall be made with ALGLAS reflector finish or with a sealed anodic coating over an electrolytically or chemically brightened specular surface. The amount of coating shall not be less than 4 mg per square inch per ASTM B 137. The coating seal shall meet ASTM B 136. The fabricator shall submit, upon request, a certification that the reflector coating meets the above requirements.
4. **Glass Reflector.** Glass reflectors shall be one piece clear borosilicate glass reasonably free from bubbles or ripples. The reflector back surface shall be protected against the effects of atmospheric oxidation and moisture.
5. **Cover Glass.** The cover glass if required shall be made of clear tempered glass. The cover glass shall be securely mounted to the holding ring with provision for easy replacement.

The cover shall be gasketed. The gasket material shall be either ethylene-propyleneteropolymer (EPT) or synthetic fiber felt.

6. **Ballast.** The ballast or ballast housing shall be mounted on the luminaire housing and shall be entirely enclosed. A gasket shall be installed between a ballast housing and the luminaire housing. The ballast shall be designed for operation at rated voltage as specified on the plans.

The ballast shall have lamp wattage and circuit voltage clearly identified as specified in ANSI C 82.4.

The ballast shall be of the regulating auto-transformer type. An applied primary voltage change of ± 10 percent of line nominal at the ballast shall cause no more than a ± 13 percent change in lamp wattage. Power factor shall be not less than 90 percent at rated voltage. The ballast must provide reliable starting at temperatures down to -20°F and with voltage variations as much as ± 10 percent of line nominal.

7. **Lamp.** The lamp shall be of the type and size specified on the plans.
8. **Socket.** The socket assembly shall be of rigid construction so that correct lamp position can be retained during service. Socket adapters for lamp positioning shall not be used. Information covering correct socket position (if variable) shall be provided. The socket material shall be nickel plated brass with a porcelain covering. The socket shall contain lamp grips and the center contact shall be spring loaded. The socket leads shall be welded or attached with crimp type, solderless, compression connectors.
9. **Wiring.** All internal wiring and connections shall be completed so that it will be necessary only to attach incoming supply conductors to pressure type connectors on a terminal block. The terminal block shall be rated at 600 volts and meet NEMA "Specifications for Wiring Terminals." The terminal board shall accommodate crimp-on solderless, compression connectors for interior wiring. The incoming supply conductors shall be mechanically and electrically fastened with compression terminals to accommodate wire from No. 12 to No. 16 AWG.
10. **Fusing.** Inline FNM type fuses shall be furnished and mounted within the luminaire housing. The current rating of the fuses shall be as follows:

Circuit Voltage	120	240	277	480
Current Rating	30	15	15	15
11. **Painting.** The luminaire housing shall be painted metallic gray.
12. **Packaging.** Luminaires shall be individually packed for shipment to ensure arrival at the project site in an undamaged condition.
13. **Assembly Drawings.** Assembly and installation drawings shall be provided.

14. **Sampling and Testing.** A Type D certification shall be provided for all tower lighting luminaires. Sampling and testing, if requested, shall be per Department methods, applicable standard specifications and the Photometric and Electrical Test Procedures.
- E. **Lowering Device.** Each tower lighting unit shall be equipped with an electric motor mounted inside the base of the tower lighting unit and a hoisting device capable of raising the specified number of luminaires plus 300 pounds to the proper operating position and lowering the luminaires to a point approximately 5 feet above the foundation. Provisions shall be made so that the raising and lowering operation may be controlled from a distance of 15 feet from the base of the pole.

The lowering device shall include a worm gear, gear reducer hoist of at least 30:1, with supporting, hoisting, and electric cables to the luminaire mounting ring.

The hoist shall be mounted inside the base of the pole with stainless steel hardware. The hoist drum shall be supplied with stainless steel cable, not less than 1/4-inch diameter, firmly attached to the hoist drum and long enough for at least one complete layer on the drum plus that required to lower the luminaire mounting ring to its lowest position.

When a single hoisting cable is used, a cable junction plate shall be furnished to join the three supporting cables to the hoisting cable and to hold the lower end of the electric cable. Such junction plate shall be accessible through the handhole when the luminaire mounting ring is in the raised position. Provision shall be made to adjust the length of each of the three supporting cables, by approximately 4 inches, with the luminaire mounting frame at the top of the pole. In lieu of such length adjustment, provision may be made for each of the three supporting cables to terminate through a coil spring under compression so that, when the luminaire mounting ring is in raised position, a difference of up to 3 inches in the length of one or two of the cables can be compensated for by differences in tension in those cables. The three supporting cables shall be stainless steel, 3/16-inch diameter.

- F. **Electric Cable.** The electrical cable shall be Portable Power Cable Type W-4 conductors, round, 600 volt, No. 8 AWG, copper consisting of 133 strands in each conductor, rated at 167 °F. The cable shall conform to ICEAS-19-81.

The same kind of cable shall be used for the electric supply from the safety switch to the terminal block in the pole and from the terminal block to the twist loc connector. That cable shall be long enough to reach through the handhole in the pole to serve as a power source for the electric drill/motor to operate the lowering device.

Where it is attached to the cable junction, the electric cable shall be held by a strain relief grip, with an insulated compression-type connector, suitable to support that cable when the luminaire mounting ring is lowered. A similar strain relief grip shall hold the other end of the electric cable where it is connected to the luminaire mounting ring.

- G. **Lightning Arrestor.** A lightning arrestor, suitable for the operating voltage and conditions, shall be mounted inside the pole base accessible through the handhole, and shall be connected between the load side of the fused safety switch and the pole grounding lug by the shortest practical connections.

- H. **Twist Loc Connector.** The Twist Loc connector shall be 600 volt, U.L. 50 amp., 3-pole, 4-wire. The power cord from the luminaire mounting ring shall have a male plug and the supply cord shall have a female plug.
- I. **Electric Drill/Motor.** An electric drill or motor shall be used to operate the hoisting device. The electric drill shall be a 240-volt heavy duty industrially rated; ½-inch capacity; electrically reversible; with special chuck to fit hoist of lowering device; with special mounting bracket for attaching to hoist through the handhole in the pole; and equipped with special electric cord.

Where an electric motor is used, a reversible, standard frame motor with a magnetic brake shall be used.

Provisions shall be made for mounting the drill/motor frame so that it may be connected to the hoist without being held by any other means. The drill/motor shall be cable of operating the hoist in either direction from this position.

The electric cord for the drill/motor shall be flexible, have heavy duty 600-volt insulation, and attachment plug to fit the 240-volt outlet in the metal pull box. A momentary push button control shall be provided, either in the electric cord for the drill or on a separate cord from the drill, to permit operating the drill in either direction or stopping it while the operator is as far as 15 feet from the pole.

A test cable for the purpose of energizing the luminaires when the luminaire mounting ring is in its lowered position shall be furnished with the electric drill/motor. The cable shall be the same kind as the electric cable up the pole, shall have proper fittings to connect the electric supply to the weathertight outlet in the luminaire frame and shall be long enough for that purpose.

- J. **Foundation.** The foundation for the tower lighting unit shall be built as shown on the plans. The anchor bolts shall be provided by the pole manufacturer for installation in the foundation.

Each anchor bolt shall be supplied with two nuts for plumbing the pole. The upper 15 inches of the bolts and the nuts shall be zinc coated according to ASTM A 153. All anchor bolts and associated nuts, washer and all hardware shall conform to subsection 908.15. Anchor bolt installation shall be according to section 810.

- K. **Fused Safety Switch.** The fused safety switch shall be as specified on the plans.

918.11 Wood Poles.

- A. All poles furnished shall be western red cedar, red pine or southern pine and shall conform to ANSI Specification 5.1 and P.L.D. *Specification for Wood Poles*.

- B. The circumferential surface area of all poles shall be incised starting from a minimum of 24 inches below the ground line and extending to a minimum of 12 inches above the ground line. All poles shall be machine shaved full length above the incised area.
- C. All poles shall be treated full length according to the *AWPA Standard for the Preservative Treatment Wood Poles*.
- D. The pentachlorophenol-petroleum preservative solution shall conform to AWPA Standards P8-64 and P9-65. The solution shall contain not less than five percent of pentachlorophenol by weight.
- E. **Support Hardware.**
 - 1. **Guys and Guy Anchors.** Guy wire shall be extra high strength grade 7-strand. Guy anchors shall be heavy two-bladed malleable iron expansion type. Guy anchor rods shall be galvanized $\frac{3}{4}$ inch by 8 foot thimble eye type. Anchor guys shall be provided with suitable metal or plastic guards.
 - 2. **Miscellaneous Hardware.** Miscellaneous pole line hardware shall be hot-dip galvanized and shall be standard products of electrical materials manufacturers.